Langley Research Center

LPR 1710.40
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SAFETY REGULATIONS COVERING PRESSURIZED SYSTEMS

National Aeronautics and Space Administration

Responsible Office: Office of Safety and Mission Assurance

LPR 1710.40

PREFACE

This Langley Procedural Requirements (LPR) is part of the Langley Facility Systems Assurance Manual. It sets forth minimum safety requirements and standards for pressurized systems within the framework of Langley Research Center safety policies and constraints. It provides professional designers and craftsmen a basis for safety and uniformity in the design, fabrication, and use of pressure vessels, piping, and associated pressure system equipment.

LAPG 1710.40, dated March 15, 2000, is rescinded and should be destroyed.

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Acting Deputy Director

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1. INTRODUCTION

1.1 PURPOSE

This document provides Langley Research Center (LaRC) general policy regarding pressure systems. It contains criteria for design, fabrication, inspection, operation, and maintenance of LaRC pressure systems, which includes hydraulic, pneumatic, propulsion, etc. The criteria set forth in this document applies to new, existing, temporary, or permanent pressure vessels, piping, and associated equipment and vacuum systems. Definitions can be found in Appendix A, Glossary.

1.2 APPLICABILITY

The intended application for this handbook is for permanently installed facility systems which typically remain a part of the facility for several years or more and are used to support more than one experimental or research project. Pressure vessels/systems for experimental systems of limited lifetime (approximately two years or less) can be approved by the LaRC Systems Operations Committee (SOC) (see LAPD 1150.2, "Boards, Panels, Committees, Councils, and Teams," Executive Safety Board), and may depend on protective barriers or enclosures and remote operation to provide an acceptable degree of safety in lieu of complying with these regulations. It also applies to pressure systems on flight vehicle simulators and flight vehicles where medium-weight (NSS/HP-1740.4) components can be tolerated. When the need for minimum weight can be demonstrated, flight components with lower safety factors may be used with fracture control measures as required by NSS/HP-1740.1, "NASA Aerospace Pressure Vessel Safety Standard." At LaRC, however, minimum-weight systems shall be considered a deviation from this regulation and must be submitted to the Pressure Systems Committee for approval (see LAPD 1150.2). Pressure vessels/systems excluded from the requirements of this handbook are listed in Appendix B, Special Requirements and Exclusions. For information regarding the Recertification (RECERT) Program, consult LPR 1710.42, “Safety Program for Maintenance of Ground-Based Pressure Vessels and Pressurized Systems” (Pending).

2. GENERAL POLICY

The general policy governing design, inspection, and certification of new and in-service pressure vessels and systems is set forth in NPD 8710.5, “NASA Safety Policy for Pressure Vessels and Pressurized Systems.” Design of all pressure systems shall also, to the maximum practical extent, comply with specific codes, standards, and LaRC supplementary requirements.

2.1 CODES AND STANDARDS

LaRC pressure vessels and pressurized systems shall comply with the following Codes and Standards:

- American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes and Piping Codes,
- National Board Inspection Code (NB-23), National Board of Boiler and Pressure Vessel Inspectors,
- American National Standards Institute (ANSI) Codes,
- Department of Transportation, Code of Federal Regulations, Title 49, Parts 171-178,
- NSS/HP-1740.1, “NASA Aerospace Pressure Vessel Safety Standards,” and
- NSS/HP-1740.4, “NASA Medium Weight Pressure Vessel Standards.”

2.2 SUPPLEMENTARY REQUIREMENTS BY LARC

LaRC pressure vessels and pressurized systems shall comply with the Supplementary Requirements as stated in the following paragraphs.

2.2.1 Gages

Gages used in pressure systems shall meet the requirements of Federal specification GG-G-76 as amended by LaRC (see Figure 2-1, Regulations for Pressure Gages). Gages which are critical to safe systems operations (that is, referenced in standard procedures) are to be calibrated in accordance with an established plan to ensure accurate measurement. All pressure gages must be mounted so that safety features will function. (Gages with blowout backs, for instance, must be mounted to allow blowout of the back in the event of over-pressurization.) Gages shall be installed on both sides of pressure regulators to ensure proper monitoring of pressures.

2.2.2 Cast Iron

Cast iron shall not be used for any pressure above 125 psig or where it will be subject to vibration, unless approved by the Standard Practice Engineer (SPE).

REQUIREMENTS	SERVICE ABOVE 125 PSIG		TYPE C SERVICE FOR 125 PSIG AND BELOW[1] [2]	INSTRUMENT GAGES, 0-30 PSIG, AND VACUUM GAGES
	TYPE A	TYPE B		
Maximum Operating Pressure	No Limit	No Limit	125 PSIG	30 PSIG
Allowable Working Pressure, % Gage Range.	80% Maximum	60% Maximum	60% Maximum	0-100%
Safety Case Construction [3] [6]	Required	Not Required	Not Required	Not Required
Proof Test Pressure	100% Range	100% Range	100% Range	100% Range
Type of Test [4]	Dead Weight	Dead Weight	Dead Weight or N_2	Dead Weight or N_2
Retest Period	Each five years	Each five years	None Required	None Required
Label for Test Certification [5] [7]	Required	Required	Required if Tested	Required if Tested

Flag Notes:

(1) Bourdon tube type, non-flight applications.
(2) Gage selection shall be in compliance with these guidelines and based on the most economical choice to satisfy the reading accuracy required.
(3) Solid front, blow out entire back area; blowout plugs will not meet this requirement.
(4) Deadweight test media to be water or oil. Oil is never to be used where gages are to be used with oxygen or oxidizing agents.
(5) Certification/calibration label to include: maximum pressure, test date, and initials of personnel; and, are to be made of aluminum foil with pressure-sensitive adhesive on the back. The label is to be 3/4" X 3/4" and a different color for each year.
(6) Provide adequate free area for discharge where blowout back gages are used.
(7) "No Certification/Calibration Required" sticker should be applied to all devices used in general service.

General Notes:

a. All gages for use at or above 125 psi shall be tested to 100% of gage range.
b. Pressure gage materials shall be selected to be corrosion resistant to pressure media and surrounding environment.
c. Pressure snubbers should be used to protect gages where pulsating pressure exists.
d. Refer special cases to the LaRC Safety Manager for recommendations.
e. Gages below 125 psi tested on request.

WARNING:

Gage user has responsibility for gage cleanliness and compatibility with service media.

Figure 2-1, Regulations for Pressure Gages.

2.2.3 Seam-Welded Pipe and Fittings

Seam-welded pipe and fittings are not to be used for a design pressure above 125 psig unless:

- The seam welds are 100% radiographed or
- The Quality Factor, as defined by the appropriate design code, is utilized in determining the minimum required wall thickness of the pipe or fitting.

Either alternative must be approved by the SPE.

2.2.4 Inspection and Hydrostatic Testing

Inspection and hydrostatic testing of instrument piping for service above 125 psig are required to the extent necessary to assure compliance with engineering design and proper material usage, fabrication, and installation.

2.2.5 Pressure Piping Systems

Pressure piping systems (except steam piping) shall meet requirements of ASME/ANSI B31.3, Process Piping.

2.2.6 Service Steam Piping Systems

Service steam piping shall meet ASME/ANSI Boiler and Pressure Vessel Code, Section I and ASME/ANSI B31.1, Power Piping.

2.2.7 Marking, Coding, and Valve Numbering

2.2.7.1 Marking and Tagging

Each certified pressure vessel/system shall be marked or tagged in accordance with NPD 8710.5, “NASA Safety Policy for Pressure Vessels and Pressurized Systems.” Methods of identification shall not introduce notches or points of stress concentration that would reduce the operational safety of the components or system.

2.2.7.2 Coding

Identification of media, flows, and color code requirements shall be as specified in LPR 1740.2, "Facility Safety Requirements" (contained in the LaRC Safety Manual). In addition, the valve numbering system shall identify media within a system as is explained in the next item.

2.2.7.3 Valve Numbering

The valve numbering system for LaRC is designed to aid in operation and maintenance of pressurized systems. Details can be found in Appendix D, Valve Numbering System.

2.2.8 Code Stamping of Pressure Systems

NASA prescribing regulation NPD 8710.5, “NASA Safety Policy for Pressure Vessels and Pressurized Systems” requires new fabrication and repairs of existing pressure vessel/systems to be in accordance with the applicable national consensus codes to the maximum practical extent. Strict compliance with some ASME codes requires

stamping of the completed system. The ASME has a procedure for stamping of new pressure vessels, and the National Board of Boiler and Pressure Vessel Inspectors has a procedure for repairs or alterations of existing coded pressure vessels; but, no procedures exist for stamping piping system repairs or alterations to uncoded pressure vessels. Early in the planning phase of projects which cannot be stamped, the technical project engineer (TPE) shall contact the Pressure Systems Manager, Systems Engineering Competency (SEC), to establish the appropriate documentation to be used. The pressure piping ("PP") stamp is used for piping inside of and up to the first valve outside of a steam boiler. Fabrication of new and repair or alteration to existing coded pressure vessel/systems shall require stamping after completion of the work, in accordance with ASME or National Board procedure. All LaRC contracts which include work requiring stamping shall contain the following note:

> *"This solicitation involves pressure vessel(s) that require a current ASME Certificate of Authorization for use of the following stamp: "U" or "U2." The Certification shall be held by the organization performing the design, fabrication, and stamping of the pressure vessel(s). The contract award process will be greatly facilitated by submittal of the applicable Certificate of Authorization with the offeror's bid; however, early certification submittal* ***is not*** *required to ensure bid responsiveness. An offeror's ability to confirm that deliverable pressure vessel(s) will be code stamped as required is a matter relating to the offeror's responsibility and will be determined prior to contract award."*

Possession of an ASME or National Board of Boiler and Pressure Vessel Inspectors stamp also is a means of verifying the capability of a contractor to perform high-quality work on pressure vessel/systems. Therefore, to assure quality work, all contracts for pressure vessel/systems which cannot be stamped shall contain the following note:

> *"This solicitation involves fabrication and/or repairs to pressure systems. A current National Board or ASME Certificate of Authorization for use of any of the following stamps: "R," "U," "U2," "N," or "PP" is required to perform this fabrication and/or repairs. This certificate shall be held by the organization performing the work. This certificate shall be maintained valid and current throughout the contract performance period. The contract award process will be greatly facilitated by submittal of the applicable Certificate of Authorization with the offeror's bid; however, early certification submittal* ***is not*** *required to ensure bid responsiveness. An offeror's ability to confirm that the organization performing the work is a holder of any of the above stamps is a matter relating to the offeror's responsibility and will be determined prior to contract award."*

2.2.9 Piping Weld Inspection

All socket and branch connection welds shall be inspected and evaluated in accordance with LPR 1710.41, "Langley Research Center Standard for the Evaluation of Socket and Branch Connection Welds." Radiographic inspection of piping girth butt welds shall utilize tangential techniques only. No elliptical techniques shall be utilized.

2.2.10 CPV-Type Union Nuts

CPV type union nuts subject to pressures above 3000 psig shall have vent holes and be torqued to the values listed in Figure 2-2, CPV Type Union Nut Torques and Vent Hole Sizes. CPV type unions 2" and larger in size shall not be used in pneumatic systems above 2400 psi unless approved by the Standard Practice Engineer (SPE) for Pressurized Systems.

2.2.11 Flex Hoses

The following requirements apply to all flex hoses except Category D fluid service hoses as defined in ASME/ANSI B31.3.

- Commercial flexible hose assemblies must be tested and labeled for operating pressure by the manufacturer. Flexible hose assemblies fabricated for in-house use by the FESS Contractor must be constructed, tested, and labeled for the specified operating pressure.
- Flex hoses shall be periodically inspected and recertified using the time intervals provided in the tables in NPR 1700.6A, “Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems,” Chapter 6. Periodic inspections will be external only. Recertification will require a visual internal examination in accordance with the ASME Boiler and Pressure Vessel Code, Section V. Hoses shall be tagged with inspection and recertification dates. Before hoses can be considered unsatisfactory for use, the following factors are to be considered:

  - Cracking or checking of the inner liner is cause for condemnation.
  - Blistering of the outer cover is usually indicative of porosity of the inner liner.
  - Flatness of areas over three inches in length is cause for condemnation.
  - Corrosion of the wire braid is cause for condemnation.
  - Worn, deeply scored, scratched, or badly corroded end fittings are causes for condemnation.

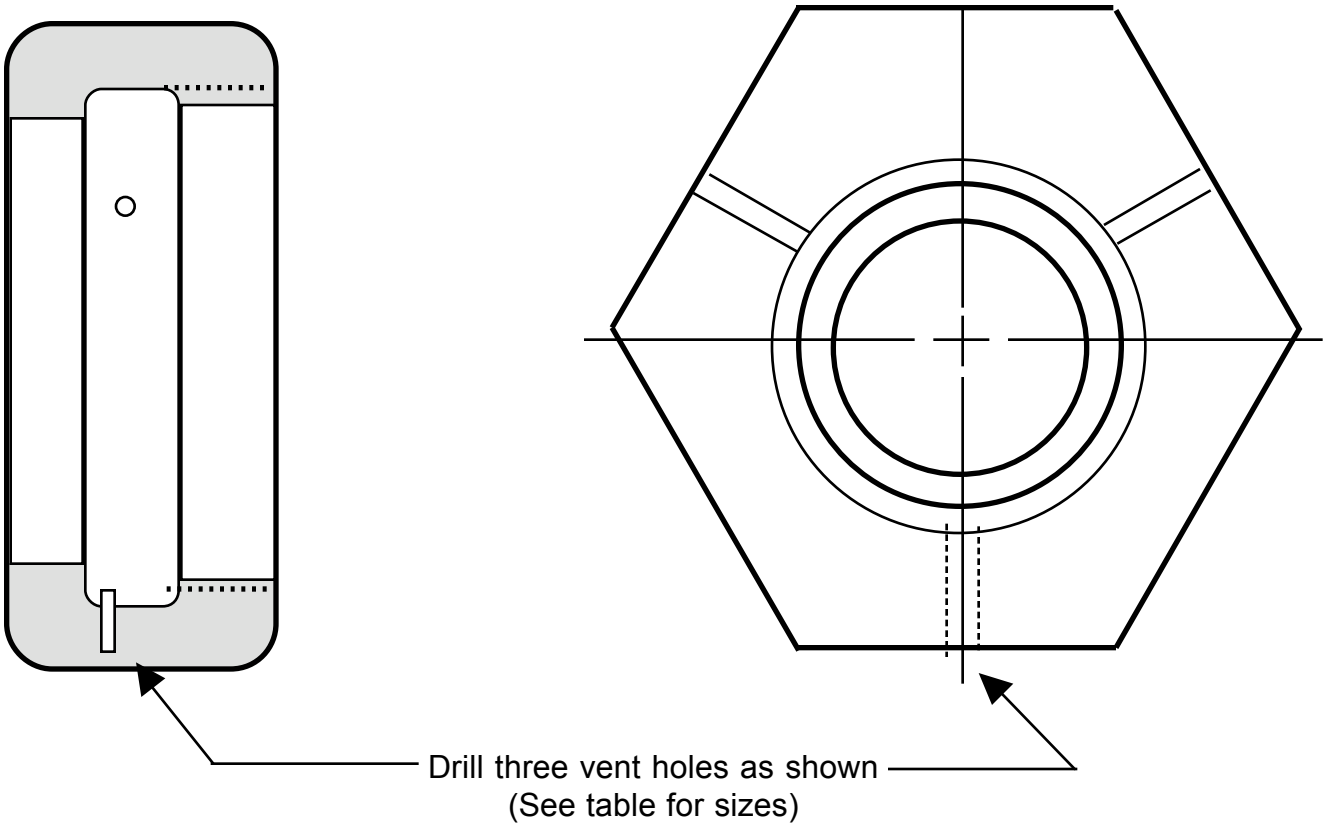
2.2.12 Single Step Hex Head Bushings

Single step hex head bushings (that is, one pipe size reduction) that have both internal and external threads shall not be used in systems with pressures above 125 psig unless approved by the SPE. All transactions of this type should be made using reducer sections.

2.2.13 Portable Support Equipment

Portable support equipment (except Category D fluid service as defined in ASME/ANSI B31.3), shall be periodically inspected and recertified using the time intervals provided in the tables of NPR 1700.6A, “Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems,” Chapter 6.

SIZE	TORQUE FT. LBS.		VENT HOLE DIAMETER
	MINIMUM	MAXIMUM	
1/8"	10	25	1/16
1/4"	10	25	1/16
3/8"	12	30	1/16
1/2"	15	40	3/32
3/4"	20	50	3/32
1"	25	60	3/32
1 1/4"	30	75	1/8
1 1/2"	35	90	1/8
2"	45	120	1/8



NOTE: Holes required when used above 3000 psi.

Figure 2-2, CPV Type Union Nut Torques And Vent Hole Sizes.

3. RULES

3.1 GENERAL SAFETY

To the maximum practical extent, LaRC personnel shall comply with the following general safety rules applicable to pressurized systems:

- Depressurization of systems shall be verified by opening vent valves or other positive means.
- NASA red tags and lock-out equipment shall be used as necessary to prevent electrical switches, air and fluid valves, or similar devices from being operated when any operation could result in injury to personnel or serious damage to equipment. (See LPR 1710.10, "Safety Clearance Procedures (Lockout/Tagout)," contained in the LaRC Safety Manual, for responsibilities and procedures.)
- For normal operations, any system containing toxic fuel or other potentially dangerous media shall be purged using approved procedures with an appropriate agent such as fresh air, water, inert gas, or a neutralizing agent prior to disassembly of components or opening up the system. If inspection and maintenance activities require personnel to enter a system, adequate air supply and ventilation requirements must be established by the Industrial Hygienist prior to entering.
- Operational procedures for pressure systems, including temporary hookups and connections, must be reviewed and approved by the Facility Safety Head (FSH).
- When underground pressure systems are being installed, modified, inspected, or recertified, a digging permit must be obtained and displayed at the site prior to removal of ground covering. (See LPR 1740.2, "Facility Safety Requirements.")

3.2 SYSTEM INTEGRITY

The safety of a pressure system must be approached on a systems engineering basis. Precautions on the constituent elements of these systems are set forth below:

- Hand valves shall not be used to regulate pressure.
- All pressurized components shall be cleaned internally before use. Many common fluids are not compatible. For example, use of oxygen in a system containing oil, or high pressure air (high concentration of oxygen) with flammable or explosive mixture, may result in an explosion. Systems requiring cleanliness to 10 parts per million or less of hydrocarbons are to be cleaned in accordance with LPR 1740.5, "Procedures for Cleaning of Systems and Equipment for Oxygen Service."

- All vessels and major units of a system shall be anchored to a foundation specifically designed to withstand all static and dynamic loads acting on the pressure system.
- Isolation valves shall not be placed upstream of relief valves.
- Pipe, tubing, and flexible hoses should be firmly secured to a stable structure at or near joints and bends to prevent violent displacement in case of joint failure.
- Accumulators should be precharged with nitrogen rather than air or other gases to prevent adverse reaction or combustion.
- Care should be taken to ensure that pressure systems are not subject to extraneous heat sources since heat raises gas pressure and reduces metal strength.
- Windows in pressure vessels exposed to pressure differentials should be avoided. They should be shielded or protected by quick-acting closures where possible. Indirect viewing rather than direct viewing should be employed wherever possible. Windows are not covered by standard codes, but a safety factor of 10 to 1 or greater is the LaRC guideline. The Standard Practice Engineer for structural glass should be consulted for window designs, including mounting. Special consideration should be given to vacuum systems and implosion effects whereby viewing windows present potential hazards. All windows in pressure and vacuum vessels must be approved by the Chairperson, Pressure Systems Committee (see LAPD 1150.2, "Boards, Panels, Committees, Councils, and Teams, " Executive Safety Board.)

4. CRITERIA

4.1 DESIGN

Design of all pressure systems shall comply to codes, standards, and the LaRC supplementary requirements of Chapter 2 to the maximum practical extent.

4.2 DOCUMENTATION

Documentation requirements for new and existing pressure vessels and systems are set forth in Chapter 7 of NPR 1700.6, “Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems.” Also, specific requirements for documentation is found in LPR 1710.42, “Safety Program for Maintenance of Ground-Based Pressure Vessels and Pressurized Systems” (Pending).

Radiographs of pressure components/equipment shall be retained by LaRC for five years. There are some welds, however, due to their history or unique condition or circumstance, whose radiographs are retained as long as the component/equipment is in service. The “Radiography Film” and a “Weld Joint Location Drawing” shall be sent to the configuration management contractor for storage/retention.

4.3 WELDING/BRAZING REQUIREMENTS AND CERTIFICATION

Welding/brazing operations on pressure systems, whether performed in-house or by contractors, will be done only by welders/brazers who are currently certified in accordance with ASME/ANSI Boiler and Pressure Vessel Code, Section IX, “Welding and Brazing Qualifications.” Welding/brazing procedures and procedural qualifying test data for pressure components must be prepared and furnished in accordance with ASME/ANSI Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications.” Submittal of these procedures and test data are not required for code stamped systems and components.

4.4 TEST REQUIREMENTS

All testing is to be performed using written and approved test plans and operating procedures. See Chapter 4, NPR 1700.6, “Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems” and LPR 1710.42, “Safety Program for Maintenance of Ground-Based Pressure Vessels and Pressurized Systems” (Pending), for recommended nondestructive tests and inspections for pressure vessels and pressurized systems.

4.4.1 Nondestructive Examination Requirements

Welded joints in pressure vessels, tubes, pipes, and fittings shall be radiographically inspected when required by applicable codes. When heat treatment or stress relieving is required, the radiographic inspection shall be performed in accordance with the appropriate ASME/ANSI codes. In addition, the joint and its heat-affected zone shall be MT or PT examined after heat treatment.

4.4.2 Hydrostatic Testing

Hydrostatic testing establishes the ability of pressure vessels, piping, and fittings to withstand the maximum pressure anticipated for the equipment. It should be conducted in accordance with the requirements of ASME/ANSI Boiler and Pressure Vessel Code VIII, Division 1 or Division 2, or ASME/ANSI B31.3, "Process Piping," or B31.1, "Power Piping." All new pressure systems shall be hydrostatically tested in accordance with their design code. Repairs to existing systems shall be hydrostatically tested unless exempted by the National Board Inspection Code, Part RC-2050. Waivers of hydrostatic testing for repairs require the approval of the SPE. Hydrostatic testing is potentially hazardous. Adequate safety precautions are to be taken to ensure the safety of personnel and equipment with regard to test procedures. After hydrostatic testing, vessels shall be dried in accordance with system requirements.

4.4.3 Pneumatic Testing

Pneumatic (pneumostatic) tests should be conducted only when hydrostatic testing is not feasible. A gas complying with cleanliness requirements of the pressure vessel and system will be used. A written procedure with line management approval is required for pneumatic testing and must then be approved by the Deputy Director for Facility Systems – Systems Engineering Competency (SEC); the Director, OSMA; and the Chairperson, Pressure Systems Committee. Pneumatic tests are inherently hazardous and all personnel must be excluded from the hazard zone. A hazard zone is to be established by a SEC engineering analysis.

4.5 WITNESSING

Hydrostatic or pneumatic testing of pressure systems used on LaRC experimental equipment, or being procured for use at LaRC, should be witnessed as follows:

- Pressure tests conducted elsewhere for systems to be used at LaRC should be witnessed by a representative such as the LaRC Resident Engineer, the design and inspection contractor, or other selected NASA personnel.
- Testing of pressure systems which are not destined to become a part of a LaRC facility, regardless of where the test is conducted, should be witnessed as determined by the responsible LaRC project manager.

4.6 ANALYSES

Analyses shall be performed in accordance with the applicable codes. Where adequate analysis techniques do not exist, or experimental correlation with theory is inadequate, the analyses shall be supplemented by tests.

4.7 DEVIATIONS

When any deviations from the criteria stated herein are required, a request for deviation shall be submitted in writing to the Pressure Systems Committee for appropriate action. The request for deviations shall include full justification for the deviation and the supporting data and analyses. The Pressure Systems Committee

will review the request and may recommend approval of the deviation to the Executive Safety Board for final approval or refer the request back to the design organization for redesign.

4.7.1 Deviations From Codes and Standards

Deviations from codes and standards (Chapter 2) must be approved by the Pressure Systems Committee through the LaRC Executive Safety Board and these are reported to NASA Headquarters per NPD 8710.5, “NASA Safety Policy for Pressure Vessels and Pressurized Systems.”

4.7.2 Other Deviations

All other deviations will be considered only by the Pressure Systems Committee and minutes of committee meetings will provide documentation of the action taken.

5. INSPECTION AND CERTIFICATION

5.1 GENERAL REQUIREMENTS

The TPE shall provide written certification that the pressure system installation is in accordance with all documentation as defined in Chapter 6, paragraph 6.1.e (1)-(7). For detail considerations necessary for pressure vessel certification, refer to Section VI of NSS/HP 1740.4 and LPR 1710.42, “Safety Program for Maintenance of Ground-Based Pressure Vessels and Pressurized Systems” (Pending). All vessels, existing or new, which are certified to this standard, shall have an in-service inspection and a recertification plan developed by the TPE (see NPR 1700.6A, “Guide For Inservice Inspection Of Ground-Based Pressure Vessels and Systems,” and the Pressure Systems Manager, Systems Engineering Competency, for guidelines). This plan should contain the criteria used in performing tests specified for recertification of individual pressure tests specified or recertification of individual pressure vessels and/or systems. Recertification of in-use pressure vessels and systems will be in accordance with this plan. Standard procedures are to be used to the maximum extent and will be performed to an established schedule that shows frequency of inspection and type of inspection to be performed.

5.2 PROCESS

The responsibilities for inspection and certification of new and in-service pressure systems rest with the responsible engineers, operations personnel, designated committees, and organizations outlined below. The following paragraphs explain the interrelations among the various activities displayed in Figure 5-1, Functional Flow Chart Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems. The lettered paragraphs are annotated on the chart for reader orientation.

a. Facility Safety Head (FSH). The FSH provides the focal point for inspection and certification. Requirements for in-service inspection, new pressure systems installations, or modifications to in-service pressure vessels/systems that affect this area of responsibility must be forwarded through the FSH. There are two loops in Figure 5-1: (1) the one for in-service inspection and (2) the one associated with new designs and changes to existing pressure systems.

b. Systems Engineering Competency (SEC). SEC is to provide policy; technical support; planning; and procedural assistance to perform nondestructive evaluation (NDE) that is required for in-service inspection and recertification in addition to any new NDE requirements.

The Zone Maintenance Section will also maintain the schedule for in-service inspection and provide the FSH the inspection requirements for the annual maintenance program. The Facility Coordinator (FC) will provide information to the

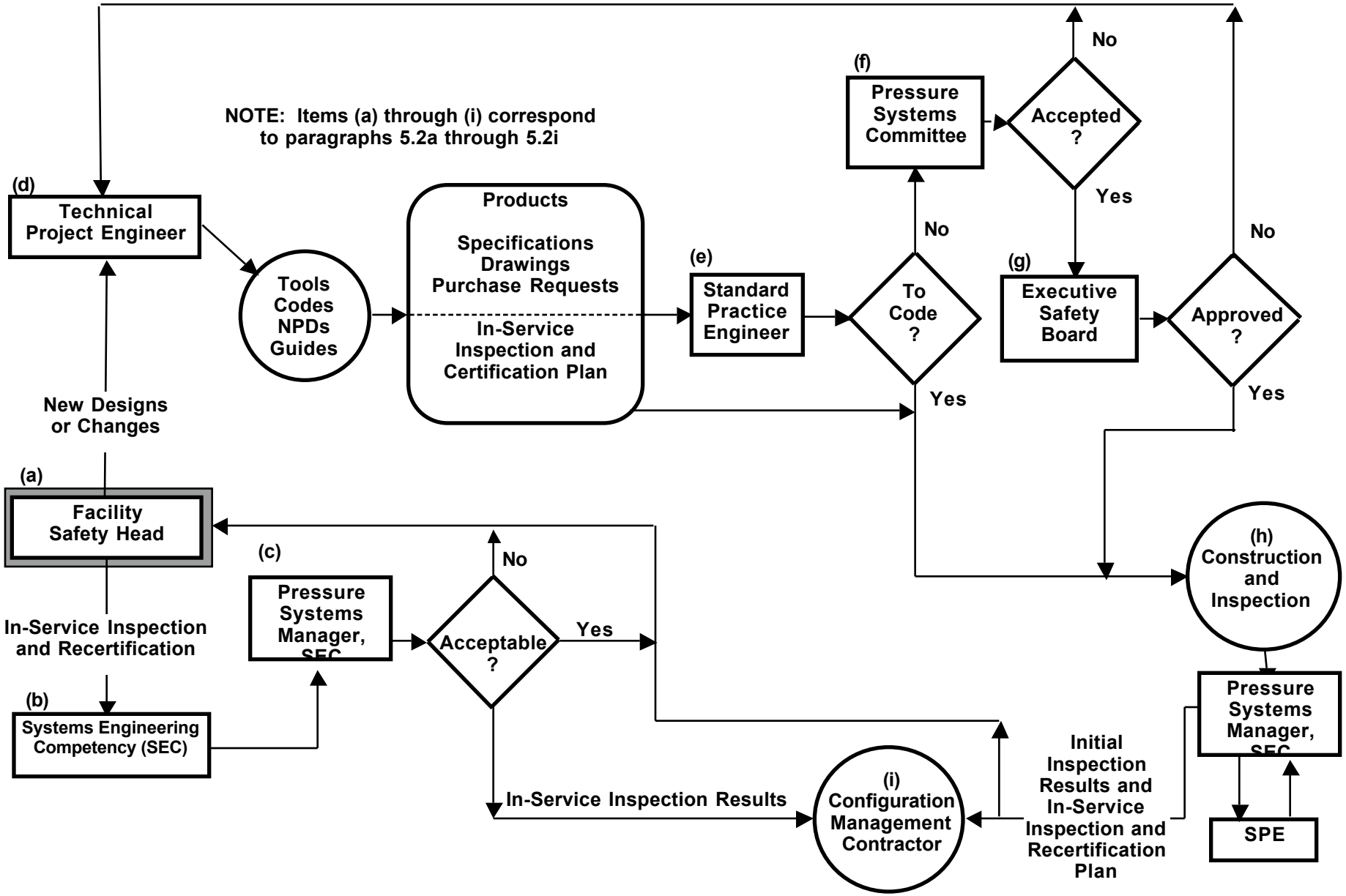


Figure 5-1, Functional Flow Chart Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems.

Zone Management Section for establishing and maintaining the inspection schedule. (Requirements will be provided to the FC by the FSH.)

c. **Pressure Systems Manager, SEC.** The Pressure Systems Manager, SEC, receives in-service inspection and certification test data for analyses. The results of the analyses provide the basis for inspection dates, re-rating, or derating requirements, modifications, and/or repairs. The Pressure Systems Manager uses the services of the RECERT and CM contractor(s) to perform in-service inspection and record keeping. When a system is certified, the findings and an in-service inspection plan are forwarded to the FSH and the configuration management contractor for future reference and scheduling. The Pressure Systems Manager issues a letter to the FSH verifying that a particular system has been recertified. If the system cannot be certified, this information is submitted to the FSH.

d. **Technical Project Engineer (TPE).** The TPE ensures that new designs, changes, or modification requirements flow from the FSH to the designer responsible for the preparation of end products such as specifications, drawings, purchase requests, and in-service inspection and recertification plan. The designer utilizes standards, codes, NMIs/NPDs, and other guidelines specified by this handbook, or equivalent, in preparing the final products for purchasing and construction. Documentation and testing results format should be sufficiently specific so as to allow a smooth transition into the LaRC PSCM and Recertification Programs. Release of this information requires normal line management approval.

e. **Standard Practice Engineer (SPE).** The SPE reviews the output from the TPE for compliance with code requirements. If code requirements are met, construction may commence. If not in compliance with code requirements, the design shall be submitted to the Pressure Systems Committee. Complete analysis of the design and calculations to support approval must accompany the design package.

f. **Pressure Systems Committee.** The Pressure Systems Committee reviews designs that are not in accordance with code and may reject the design. If rejected, the design is returned to the responsible designer for rework. If the committee approves the design, it is then submitted with a recommendation for final approval to the Executive Safety Board.

g. **Executive Safety Board (ESB) (see LAPD 1150.2, "Boards, Panels, Committees, Councils, and Teams," Executive Safety Board).** The ESB approves or rejects the design. . If rejected, the design is returned to the responsible designer for rework and reprocessing through the approval cycle. Deviations, when granted, are to be reported to NASA Headquarters according to NPD 8710.5, “NASA Safety Policy for Pressure Vessels and Pressurized Systems”.

h. **Construction Management Team/Pressure Systems Manager/SPE.** During construction, inspection and associated field services may be supplied by either government or contractor personnel. The TPE provides liaison and consulting expertise. The Pressure Systems Manager provides consulting expertise on development of the In-service Inspection and Recertification Plan. Upon completion, data supplied from installation tests are supplied to the Construction Management Team, the Pressure Systems Manager, and the SPE as necessary. The Pressure Systems Manager forwards the Initial Inspection Results and In-Service Inspection and Recertification Plans to the CM contractor.

i. **Configuration Management Contractor.** Receives data for both new and in-service pressure vessels and systems test results for updating the inspection and recertification plan from the two loops shown in Figure 5-1. This data will be provided to the FSH and to EDF with the required schedules for future inspection and recertification.

6. RESPONSIBILITIES

6.1 FACILITY SAFETY HEAD (FSH)

The FSH is to:

- Ensure that the basic requirements for pressure systems of the organizational unit will fulfill the required objectives; and, that these requirements are clearly defined.
- Ensure that all new pressure vessels, piping, associated equipment, and all modifications thereto are approved by the SPE for Pressurized Systems and/or the LaRC Formal Design Review process before commencing site work.
- Ensure the conduct of the organizational unit's safe operation. This handbook does not relieve the FSH of this responsibility.
- Furnish a copy of this handbook to each employee of the organizational unit who performs or may be called upon to perform duties described herein; and, ensure that each of these employees is familiar with and complies with the provisions of this handbook and other related LaRC safety regulations.
- Possess written verification of the following information prior to the initial operation of any pressure system:

  - That the design conforms to the regulations herein or that any deviations have been approved by the Pressure Systems Committee.
  - That the installation has been completed according to the design, specifications, drawings, and change items.
  - That the Pressure Systems Committee and/or a formal design review committee has reviewed, for safety consideration, plans for construction, additions, or alterations and the initial startup and checkout procedure to be employed according to applicable prescribing LaRC instruction.
  - That the Committee on Potentially Hazardous Materials (see LAPD 1150.2, "Boards, Panels, Committees, Councils, and Teams," Executive Safety Board), has reviewed, for safety consideration, any pressure vessels, piping, and associated equipment which utilizes or employs a material that may be hazardous if not properly handled.
  - That the appointment of a FC and any necessary alternates has been made.
  - That the appointment of Safety Operators and any necessary alternates have been made in accordance with LPR 1710.10, “Safety Clearance Procedures (Lockout/Tagout).”
  - That proper safety training has been given to Equipment and Safety Operators.

  NOTE: Written certification is obtained from the TPE for the first four items above.
- Complete the following prior to the scheduled operation:

- Review operational procedures for changes, additions, or alterations that were found necessary during the initial operational checkout.
- Establish procedures outlining routine operational inspection and retest periods.
- Establish emergency operating procedures.
- Have a complete set(s) of final drawings, design specifications, design analysis manuals, and schematic drawings required for safe and proper operation.

- Maintain documentation (drawings, procedures, safety analysis, etc.) required for safe operation of pressurized systems.
- Provide coordination for modification, new installations, maintenance, and re-certifications of pressurized systems and equipment.
- Ensure that proper identification, labeling, color coding of components and/or system are maintained.
- Maintain current logs, schedules, history of inspections, and recertification of facility pressure systems.
- Maintain complete documentation on pressure vessels three cubic feet or greater and/or working pressures in excess of 150 psig.

6.2 FACILITY COORDINATOR (FC)

The FC is to assist the FSH in achieving safe operation of the building complex and research facilities. Additional responsibilities of the FC are to:

- Initiate requests for maintenance, repairs, modification, or alterations to the facility.
- Notify and obtain clearance from other coordinators within the facility for any proposed work requiring utility disruption.
- Coordinate the operations procedures of equipment in the facility so that the use of common utilities does not create a safety problem.
- Maintain a procedure for obtaining clearance for proposed work in the facility.
- Stop any work being performed which is not in accordance with appropriate regulations, and notifying the Safety Manager.
- Control Lockout/Tagouts and have an authorized Safety Operator attach them to electrical switches, air and fluid valves, or similar control devices when operation would cause injury or damage.

6.3 SAFETY OPERATOR

A Safety Operator (see LPR 1710.10, “Safety Clearance Procedures (Lockout/Tagout)”) is to provide safety clearance procedures prior to performing any work on pressure vessels and/or pressurized systems. This includes the responsibilities of properly installing and removing lockout/tagouts.

6.4 EQUIPMENT OPERATOR

The Equipment Operator, certified by line management, is to:

- Be knowledgeable in all aspects of equipment to be operated.
- Maintain logs of equipment startup, operation, and shutdown.
- Assist in removal of pressure equipment from service and preparation for in-service inspections.

6.5 TECHNICAL PROJECT ENGINEER (TPE)

The TPE is to:

- Provide for the basic pressure systems requirements specified by the FSH, retaining the responsibility for pressure systems up to and including the final systems acceptance testing. This includes the responsibility for all coordination necessary to assure compliance with these regulations by the FC, FSH, designer, SPE, inspector, radiograph interpreter, fabricator, installer, and the appropriate committee of the Executive Safety Board (ESB) (see LAPD 1150.2, "Boards, Panels, Committees, Councils, and Teams"). Ensure that an inspector is assigned to inspect all new pressure vessels, piping, and associated equipment and all alterations, repairs, and additions thereto.

6.6 INSPECTOR (DESIGN AND INSPECTION CONTRACTOR)

The inspector is to:

- Ensure that the fabricator and the installer conform to the applicable portions of specifications.
- Witness all tests specified by the designer.
- Verify that test apparatuses are calibrated properly before use.
- Ensure that all non-destructive evaluation (NDE) inspection personnel performing inspections, evaluating inspection results, or interpreting radiographs are qualified in accordance with American Society for Non-Destructive Testing (ASNT) SNT-TC-1A, "Recommended Practice for Non-Destructive Testing Personnel Qualification and Certification." Personnel qualified to Level I are utilized only under the field supervision of a currently certified Level II or III inspector.
- Coordinate with the TPE in resolving any problems in the interpretation of specifications that involve these regulations.
- Ensure that all radiographs of LaRC pressure systems are reviewed by an NDE Operations Certified Radiographic Interpreter.

6.7 STANDARD PRACTICE ENGINEER (SPE) FOR PRESSURIZED GROUND SYSTEMS

The SPE for Pressurized Ground Systems is to review and approve all new in-house designs of pressure systems or modifications to existing systems and to certify their compliance with existing codes. Any systems which do not comply with these codes are to be referred to the Pressure Systems Committee.

6.8 STANDARD PRACTICE ENGINEER (SPE) FOR PRESSURIZED FLIGHT SYSTEMS

The SPE for Pressurized Flight Systems is to examine drawings, test plans, operational procedures, checkout procedures, purchase requests, specifications, and statements of work. The SPE either approves them as conforming to these regulations or directs that they be submitted to the Pressure Systems Committee.

6.9 RADIOGRAPHIC INTERPRETER

The Radiographic Interpreter is to review all radiographs produced at LaRC or furnished by support contractors, equipment manufacturers, vendors, or others which pertain to pressure systems or components governed by this handbook. The interpreter shall review and interpret radiographs based on the appropriate acceptance criteria.

Appendix A

A. GLOSSARY

Associated Pressure Systems Equipment: Any pressurized component which Is required for the use or operation of pressurized systems covered by these regulations.

Codes, Standards, and Guides: The reference to codes, standards, and guides within the text of this handbook includes national consensus codes, agency-wide and LaRC-wide standards which are required in design, inspection, certification, and operation of all pressure vessels and pressurized systems, both new and existing at LaRC. Codes, standards, and guides referred to in this document are available from the Recertification Team, Engineering Support and Facility Projects Branch, Facility Systems Engineering Division.

Contractor: Any company or organization who does work for or who supplies equipment to LaRC.

Designer: Anyone authorized by the government to perform work in accordance with standard engineering practices, codes, and LaRC safety regulations.

Deviation: The design, fabrication, inspection, or use of pressure vessels, piping, and associated equipment which is not in compliance with the codes, standards, and guides (defined above).

Equipment Operator: Anyone authorized by the government to operate, in normal use, the pressure vessels, pressure systems, piping, and associated equipment covered in these regulations. Operators must be qualified by appropriate training in the operational characteristics and procedures of the equipment system that they operate.

Fabricator, Installer: Anyone authorized by the government to perform work in accordance with standard trade practices, codes, LaRC specifications, and safety regulations.

Inspector: Anyone authorized by the government and/or authorized by LaRC to assure that fabricators and installers follow the scope and intent of the design specifications.

Pressure:

- **Design Pressure/Maximum Allowable Working Pressure:** This pressure shall be used in the design of a vessel for the purpose of determining the

minimum permissible thickness or physical characteristics of the different parts of the vessel. When applicable, static head shall be included in the design pressure to determine the thickness of any specific part of the vessel. The pressure relief devices shall be set to initially operate at a pressure not exceeding the maximum allowable working pressure of the vessel.

- **Operating Pressure:** This pressure is the operating pressure of the vessel system. For pressure vessels, it should be 5 to 10% less than the maximum allowable working pressure. This avoids relief device discharging at normal operating pressure due to the manufacturer's tolerance on set pressure and allows for resetting of a safety valve after relieving over pressure. For piping systems, the relief device shall be set in accordance with the appropriate piping code (ASME/ANSI B31.3, "Process Piping," or ASME/ANSI B31.1, "Power Piping").

Pressure Systems Committee (PSC): The PSC is one of the committees reporting to the ESB as set forth in LAPD 1150.2, "Boards, Panels, Committees, Councils, and Teams," Executive Safety Board. This committee conducts reviews and provides written approval or recommends for approval to the ESB deviations from code on pressurized systems/components; provides guidance and consulting service for safety and design of these systems; recommends, adopts, and/or interprets requirements of codes, standards, and design application for pressurized systems; and maintains an overview for developments in the field of pressure systems regarding new codes/modifications, new techniques, and improvements or applications thereof.

Radiographic Interpreter: An individual trained and qualified to the ASNT SNT-TC-1A Level-II position, certified by a LaRC individual that holds a current "ASNT Level-III certification."

Recertification: A verification of the pressure vessel/system suitability for continued safe service based on periodic inspection, testing, and analysis. (See LPR 1710.42, “Safety Program for Maintenance of Ground-Based Pressure Vessels and Pressurized Systems" (Pending)).

Standard Practice Engineer(s) (SPE): The persons designated in LAPD 1150.2, "Boards, Panels, Committees, Councils, and Teams," Executive Safety Board, to review and approve the design and specifications of all pressurized ground and flight systems, and verify compliance with applicable codes, standards, and supplementary requirements of these regulations including granting of waivers of hydro test for repairs.

Office of Safety and Mission Assurance (OSMA): The LaRC organization that provides a point of contact between NASA Headquarters and other external organizations regarding safety matters per LAPD 1700.2, "Safety Assignments," participates in formulation and implementation of safety policy, ensures safety reviews of all systems, assures a testing and certification program for specialized

operators, and assists the Contracting Officer's Technical Representative in determining the adequacy of the contractor's safety programs.

Technical Project Engineer (TPE): The individual employed by the government and authorized by LaRC to supervise and coordinate the design of pressure vessels, pressure systems, piping, and/or associated equipment.

Temperature:

- **Maximum Design Temperature:** The maximum temperature used in the design of a vessel for the purpose of determining the minimum permissible thickness or physical characteristics of the different parts of the vessel.
- **Minimum Design Temperature:** The minimum temperature used in the design of a vessel for the purpose of determining the physical characteristics of the different parts of the vessel.

B. SPECIAL REQUIREMENTS AND EXCLUSIONS

B.1 SPECIAL REQUIREMENTS

B.1.1 Inspection/Recertification of Cryogenic Storage Vessels and Trailers

Cryogenic storage vessels and trailers at LaRC do not require periodic recertification but are to be visually inspected for frosting on the outer surface of the outer tank on a weekly basis. When frost is visually detected, appropriate measures must be taken to reestablish the proper annulus vacuum level. The annulus vacuum level is to be verified (500 microns or less) at least twice a year for cryogenic storage vessels and trailers that, by design, incorporate connections for annulus vacuum monitoring and pumping. Cryogenic storage vessels and trailers of this type are provided with redundant relief protection, that is, a rupture disc and relief valve. Recertification of relief valves is to follow the guidelines stated in NPR 1700.6A, "Guide for In-Service Inspection of Ground-Based Pressure Vessels and Systems." The inner tank rupture disc is to be replaced at the time of relief valve recertification.

B.1.2 Pneumatic Testing of Cryogenic Systems

Pneumatic testing of cryogenic systems in lieu of hydrostatic testing is permissible provided other approvals required by the regulation are met.

B.2 EXCLUSIONS

B.2.1 Portable Air Compressors

Portable air compressors designed to operate at 125 psig or lower are excluded from the requirements of this handbook. NPR 1700.6A is the basis for this exclusion.

B.2.2 Hydraulic Accumulator-Type Pressure Vessels

Individual variation in both vessel design and system installation needs to be considered. The pressure-volume relationship for gases that is described in NPR 1700.6A shall be used as a basis to exclude such accumulators from the requirements of this handbook, that is, the gas side pressure-volume multiple less than 5,000 psi-cubic feet (e.g., 500 psig x 10 cubic feet = 5,000). This basis shall be used for both new and existing systems at the service condition (combination) of maximum gas energy potential.

B.2.3 Hydraulic Components

Hydraulic components, covered by the National Fluid Power Association, are excluded from the requirements of this handbook. However, systems in which these components are used shall be reviewed by the Standard Practice Engineer.

B.2.4 Fire Extinguishers

These items are covered by Code of Federal Regulations Title 29 - Labor (CFR 29), Chapter XVII - OSHA PART 1910, Subpart L and include:

- Portable extinguishers,
- Stand pipe and hose systems,
- Automatic sprinkler systems,
- Fixed dry and wet chemical extinguishing systems,
- Carbon dioxide extinguishing systems, and
- Alternative gas (environmentally friendly) extinguishing systems.

B.2.5 Refrigeration Systems

Refrigeration systems are excluded from the requirements of this handbook. These systems are covered by the American Society of Heating, Refrigeration and Air Conditioning Engineers Regulations and Manufacturers' Specifications.

B.2.6 Over-the-Road Trailers

Over-the-road trailers with pressurized components are excluded from the requirements of this handbook. These trailers are covered by Department of Transportation regulations.

B.2.7 Water Systems

Water systems operating at pressures less than 100 psi and temperatures less than 212º F are excluded from the requirements of this handbook.

B.2.8 Pressurized Components

Pressurized components described in LPR 1710.15, "Wind-Tunnel Model Systems Criteria," are excluded from the requirements of this handbook.

B.2.9 Utilities

Many pressure vessels and systems in use at LaRC fall into a utility category and present minimum potential hazard. Typically, these are pressure vessels/systems (i.e., water heaters, space heaters, or similar general utility services) that meet the guidelines established in NPR 1700.6A, "Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems."

B.2.10 AIR-PAK Rescue Equipment or other Self-Sustaining Breathing Apparatuses

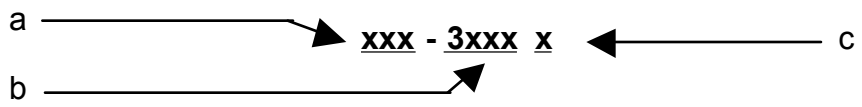
The items are covered by 29 CFR, Chapter XVII-OSHA Part 1910, Subpart I, Sections 1910.134 through 1910.140.

C. VALVE NUMBERING SYSTEM

C.1 VALVE NUMBERS

C.1.1 Numbering System

A standard valve numbering system for all LaRC facilities has been instituted that is compatible with the computer-aided maintenance system and eliminates number duplications. This system is based upon the use of seven (7) digits plus one suffix. A complete number, as it appears on a valve tag, is as follows:



a. The first three digits identify the building in which the valve is located. These buildings are identified in Table C-1.

b. The next four digits identify the particular device number. The valve in the example above is in the 3000 series.

c. The suffix identifies the type of system in which the device is located. They are:

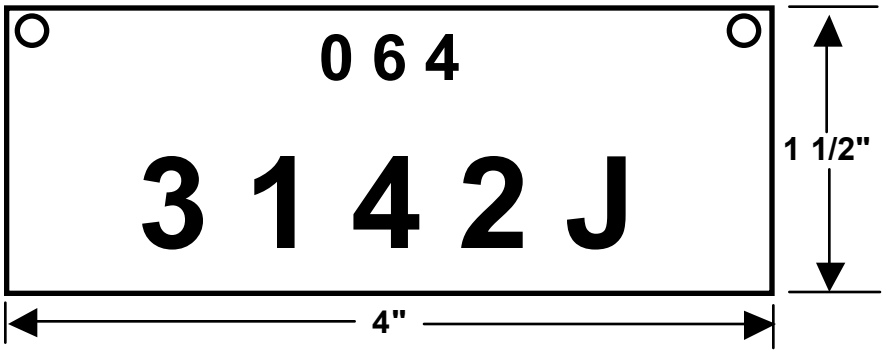
SUFFIX	SYSTEM
A, B, C, D & E	Air
F	Fuel (except Hydrogen)
H	Hydrogen
J & K	Helium
N & M	Nitrogen
P	Hydraulic Fluid
Q	Lubricating Oil
R	Other Inert Material
S & T	Steam and Condensate
U & W	Water
V	Vacuum
X	Oxygen, Oxidizers
Y	Freon
Z	Fluid Combinations

Thus, a typical valve number would appear as 064-3142 J, which would identify the device as being number 3142 in the helium system in Building 1247B.

The letter "Z" designates that more than a single fluid can be transported through the piping system. Anyone performing maintenance on a valve with this suffix, or disassembly of a system identified by this suffix, should be immediately alerted to the requirement to positively identify the system's media before maintenance or disassembly begins.

C.1.2 Tags

Tags applied to each device would appear similar to the following illustration:



For operating procedures, it would be sufficient to refer to the device as "thirty-one forty-two jay" - the building identifier being necessary only for maintenance services.

C.2 IMPLEMENTING THE VALVE NUMBERING SYSTEM

The identification system will be used on all valves and valve-type devices (that is, regulators). To avoid operational confusion during the transition phase and to assure minimum impact, the following ground rules apply:

a. Where possible, suffix letters providing a generic tie-in will be given priority when assigning numbers to valves in the basic operating control loop of a particular system. These will be the valves normally appearing in a single standard procedure.

b. In building complexes where several sets of research apparatuses (tunnel test sections) are serviced by a common distribution or vacuum systems, no two valves will be assigned the identical number. In other words, the distribution/evacuation system operating procedure would have no nomenclature ambiguities (same number and suffix with only differing identifiers).

c. To minimize the impact of identification change, all valves, associated components, and particularly graphic panel identifications will bear both the old and new numbers until procedures have been demonstrated and operators are familiar with the new nomenclature. This will also provide adequate lead time for procurement of new name plates and tags.

d. A cross-index of old and new device numbers will be made a part of facilities baseline documentation. This will enable the update of missing drawings,

possibly located as a result of some future drawing file purge, and will serve as a historical record. The cross-index may assume the form of a drawing.

e. For new facilities, or the addition or modification to existing facilities, engineering design personnel should estimate the total valve numbers required, then request a block of numbers from the cognizant Facility Safety Head (or the Facility Safety Head's Facility Coordinator).

Table C-1, Building Identifiers for Equipment Maintenance Numbers.

Building Number	Identifier	Building Number	Identifier
581	1	1164	118
582	2	1165	143
582A	3	1166	162
583	4	1167	163
583A	5	1168	128
584	8	1169	132
585	3	1170	133
640	9	1171	134
641	10	1172	135
642	21	1173	136
643	11	1174	182
644	15	1175	166
645	14	1176	177
646	13	1177	178
647	12	1181	180
648	19	1183	175
650	20	1186	176
720	18	1187	181
720A & B	18	1188	173
1120	149	1189	174
1121	184	1190	170
1122	179	1191	172
1130T	107	1192	52
1133	156	1192A,B,C,D & E	52
1145	167	1194	30
1146	22	1195A & B	33
1147	82	1196	185
1148	23	1197	168
1149	24	1198	160
1151	35	1199	85
1152	26	1200	74
1153	79	1201	39
1154	83	1202	75
1155	78	1203	120
1156	112	1204	102
1157	113	1205	76
1158	114	1206	81
1159	115	1207	69
1160	116	1208	97
1161	117	1209	125
1162	140	1211	155
1163	25	1212	43

Table C-1, Building Identifiers for Equipment Maintenance Numbers (Continued).

Building Number	Identifier	Building Number	Identifier
1212B & C	43	1247D & G	66
1213	42	1247E	67
1214	165	1248	80
1215	41	1249	57
1216	169	1250	77
1218	36	1251	50
1218A	36	1251A	150
1219	37	1252	92
1220	49	1253A	89
1221	40	1254	158
1221A,B,C,D & E	40	1255	137
1222	54	1256	63
1223	29	1257	51
1223A	123	1258	51
1224T	171	1259	51
1225	44	1260	51
1227	86	1261	124
1228	56	1262	68
1229	45	1263	48
1229A	45	1264	151
1230	47	1265A-E	28
1230A & B	47	1266	90
1231	46	1266F	100
1232	55	1267	31
1232A	53	1267A & B	31
1233	34	1268A & B	70
1234	22	1270A & B	103
1235	58	1271	104
1236	59	1272	105
1237A,B & C	93	1273	106
1238A & B	27	1273A	106
1239	87	1274	69
1240	81	1274B	69
1241	61	1275	69
1242	122	1276	183
1243	88	1277	145
1244	60	1278	107
1244A,B,C & D	60	1279	107
1245	81	1281	107
1246	81	1283	108
1247B & H	64	1283A	108
1247A, C & F	65	1284A & B	109

Table C-1, Building Identifiers for Equipment Maintenance Numbers (Continued).

Building Number	Identifier
1284C	119
1285	139
1286	110
1287	126
1288	142
1289	96
1290	84
1291	95
1292	38
1293A & B	62
1294	111
1295A-D	250
1296	31
1297A & B	71
1298	72
1299	73
1299A-E	73
1300	130
1310	129
1312	91
Forklifts	94
Slings	98
Lifting Devices	99
Emergency Lights	101
Link Boxes (GW)	141
Outside Light (Poles)	144
Relays	146
Fire Alarm System	147
Sprinkler System	148
Tube-Type Trailers	152
Fire Hydrants	154
Fuel Tanks	159
Domestic Water Valves	164